Idaho State Department of Agriculture

Idaho Dairy Ground Water Nitrate Monitoring Results

Gary Bahr and Rick Carlson

ISDA Technical Results Summary #5 December 1, 2000

Introduction

The Idaho State Department of Agriculture (ISDA) is monitoring ground water nitrate concentrations at all dairies in Idaho. This program is implemented jointly by the Dairy Bureau and the Division of Agricultural Resources Water Quality Program within ISDA. ISDA's Dairy Bureau implements the Rules Governing Dairy Waste, IDAPA 02.04.14 (Dairy Waste Management Program). Under these rules, dairy operations are mandated to prevent ground water contamination. Dairies also must operate in compliance with the Idaho Ground Water Rule of 1997 (IDAPA 16.01.11).

As part of this regulatory responsibility, ISDA is working with dairies to ensure compliance of waste systems for the protection of ground water quality. ISDA has developed a tiered approach for monitoring nitrate concentrations at dairy wells and to assess the source of nitrate detected in underlying ground water. Once a determination of nitrate source is complete, operational changes can be addressed to prevent further contamination.

This tiered monitoring approach consists of the following general steps:

- Sample well(s) at each dairy for nitrate.
- Collect related well information for each dairy from the Idaho Department of Water Resources (IDWR) and the dairy operator or owner.
- Determine applicability of well information to local hydrogeology and dairy operation.
- Determine range of nitrate concentrations from sampling data.
- Conduct ground water nitrogen isotope ($\delta^{15}N$) testing at dairies that have nitrate above 10 milligrams per liter (mg/L) and then at dairies that have nitrate between 5 mg/L and 10 mg/L.
- Conduct more extensive ground water monitoring studies at dairies that have nitrate above 10 mg/L, and that have nitrogen isotope ($\delta^{15}N$) values that indicate a possible animal waste source.
- Conduct comprehensive assessments at those dairies that have nitrate about 10 mg/L.
- Conduct animal waste system evaluations (i.e., evaluate lagoons, nutrient management plans, etc.), and implement changes.
- Make conclusions based on best available data, information, and science.
- Where needed, install monitoring wells up and down gradient from dairies.
- Sample and test monitoring wells to determine nitrate source.
- Work with nondairy sources of nitrate to prevent further contamination.
- Evaluate success of implemented changes.

Purpose

The purpose of this effort is to further characterize ground water quality underlying dairy operations, to determine nitrate concentrations and sources, and to take corrective measures where needed. When initial testing indicates a concern relative to nitrate, further assessment will be conducted to determine relative contaminant contributions from

potential nitrate source(s). The information will be used to make regulatory and voluntary management changes on land contributing to the problem. ISDA is the lead water quality agency for this project and for regulating dairies.

Methods

In 1999 through 2000, ISDA sampled at least one well at every dairy in Idaho. ISDA dairy inspectors conducted the sampling within each inspection region. The Environmental Hydrogeologist and Agricultural Bureau Chief within the Division of Agricultural Resources Water Quality Program provided technical support for this effort.

Wells were sampled following ISDA standard operating procedures for ground water testing (i.e collection, handling, shipping, transfer). Water samples were tested for nitrate using EPA approved methods at various certified Idaho laboratories (Table 1). A few wells that were elevated in nitrate were retested for confirmation of results.

Table 1. List of laboratories and analytical methods used for testing.

Inspector Region	Laboratory	EPA Method
Northern	Health and Welfare Laboratory, Coeur d' Alene	EPA 353.2
Southwest	Analytical Laboratory, Boise	SM4500E
Southcentral	Magic Valley Laboratory, Twin Falls	SM4500D
Southeast	Health and Welfare Laboratory, Boise	EPA 353.2
Eastern	Forsgren Associates, Inc. Rexburg	SM4500E

Results

Ground Water Nitrate Data for Dairies

General Distribution of Data

As of July 2000, testing of ground water wells at 761 out of 942 Idaho dairies had been completed. The majority of ground water samples (720 or 95 %) tested had positive nitrate detections (Table 2). Of the dairy well locations tested, 340 or 45 % tested below the natural background level for nitrate of 2 mg/L (Neely and Crockett, 1999). The number of locations with nitrate levels between 2 and 5 mg/L was 237 or 31 %. The number of locations with nitrate levels between 5 and 10 mg/L was 141 or 19 %. The number of wells with nitrate levels over 10 mg/L to date was 43 or 6 %. From 1991 through 1993, IDWR found 3.5% of their program wells had nitrate above 10 mg/L (Crockett, 1995). Locations of dairy wells exceeding 10 mg/L for nitrate are shown in Figure 1.

Table 2. Distribution of nitrate concentrations in 761 dairy wells sampled from September 1999 to July 2000.

Nitrate Concentration Range (mg/L)	Number of Wells	% of Dairy Well Locations
ND (< 0.05 mg/L)	41	5 %
ND – 2	299	39 %
2 – 5	237	31 %
5 – 10	141	19 %
> 10	43	6 %
Total	761	100%

Elevated Nitrate Detections

Of the 43 sites that tested over 10 mg/L, 38 % are between 10 and 20 mg/L (Table 3). Four sites are between 20 and 30 mg/L, and one site is over 40 mg/L. A maximum value of 42 mg/L is located in Blaine County. All sites over 10 mg/L are in southern Idaho (Table 3).

Table 3. Nitrate concentration ranges, number of detections, and counties related to dairy well sites that were over 10 mg/L.

Nitrate Concentration Range (mg/L)	Number of Detections	Counties
10 – 20 mg/L	38	Ada, Bear Lake, Bingham, Canyon, Cassia, Franklin, Fremont, Gem, Gooding, Owyhee, Payette, Twin Falls
20 – 30 mg/L	4	Ada, Bingham, Caribou, Fremont
30 – 40 mg/L	0	None
> 40 mg/L	1	Blaine

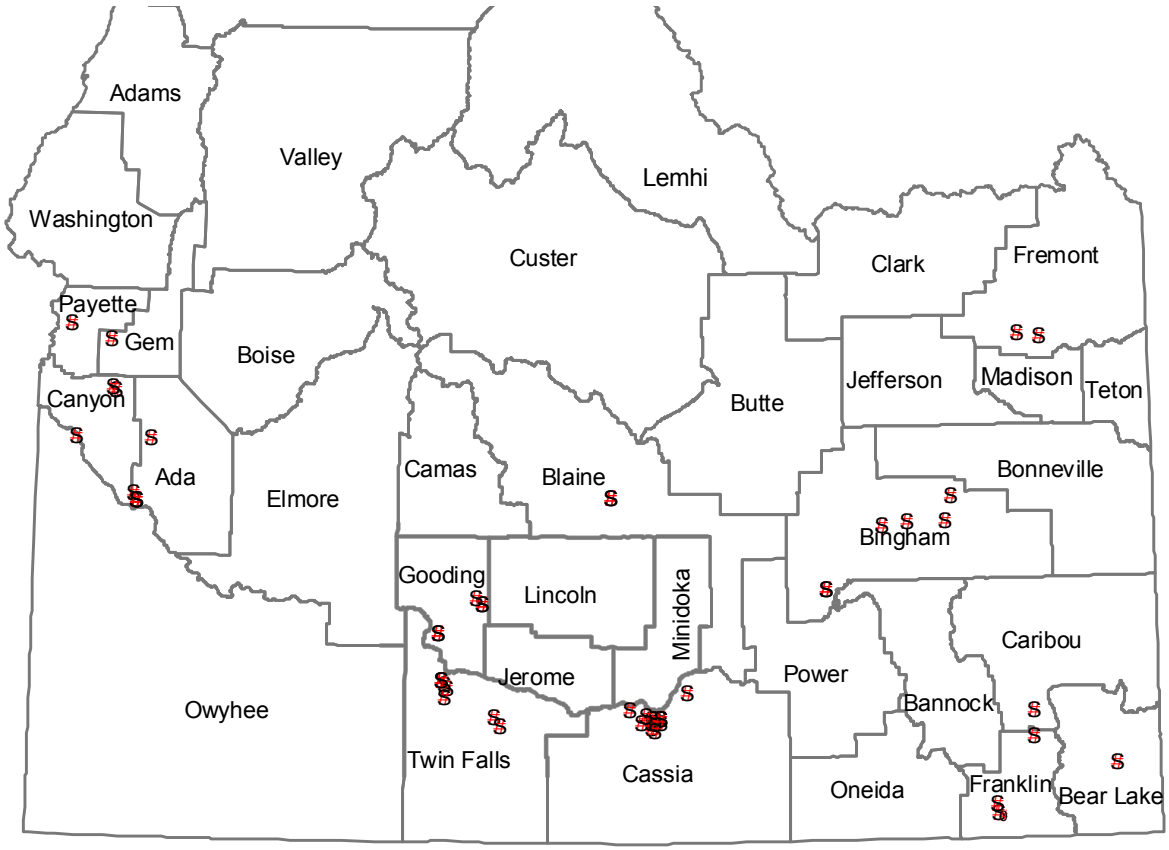

Figure 1. Map of dairy locations that have one or more wells with nitrate concentrations greater than 10 mg/L.

Nitrate Data for Each Inspector Area

Nitrate data per dairy inspection area are displayed in Figure 1. Data indicates that the lowest ground water nitrate levels at dairy locations occur in Northern Idaho with a high value of 7.77 mg/L, a mean value of 1.49 mg/L, and median value of 0.13 mg/L (Table 4). South central Idaho has the highest nitrate value (42.0 mg/L) in Blaine County (Figure 1). Southwestern Idaho has the highest mean value of 4.45 mg/L (Table 4). The highest nitrate values for the other areas are 22.95 mg/L for southwestern, 26.1 mg/L for southeastern, and 27.25 mg/L for eastern Idaho areas (Table 4).

Comparison of Dairy Data to IDWR Statewide Data

IDWR statewide ground water monitoring data was compared to dairy well sample data. IDWR samples approximately 400 randomly selected wells per year and tests for nitrate and other parameters as part of the Statewide Ambient Ground Water Monitoring Program (Statewide Program). The Statewide Program data is based on a random sampling design versus the ISDA dairy data comes from wells located at dairies. However, both sampling programs include wells within similar hydrogeological subareas (Table 4). The IDWR recommended data selected for this comparison was collected between the 1991 and 1994 sampling seasons.

The design and the population of wells tested in the two programs vary. In each of the 20 hydrogeological subareas of the state, the IDWR program randomly selected wells are sampled each year. On a four year cycle they rotate wells in and out of the sampling program. A small percentage of wells are visited annually (Neely and Crockett, 1998). The total number of well locations listed in Table 4 represent the total number

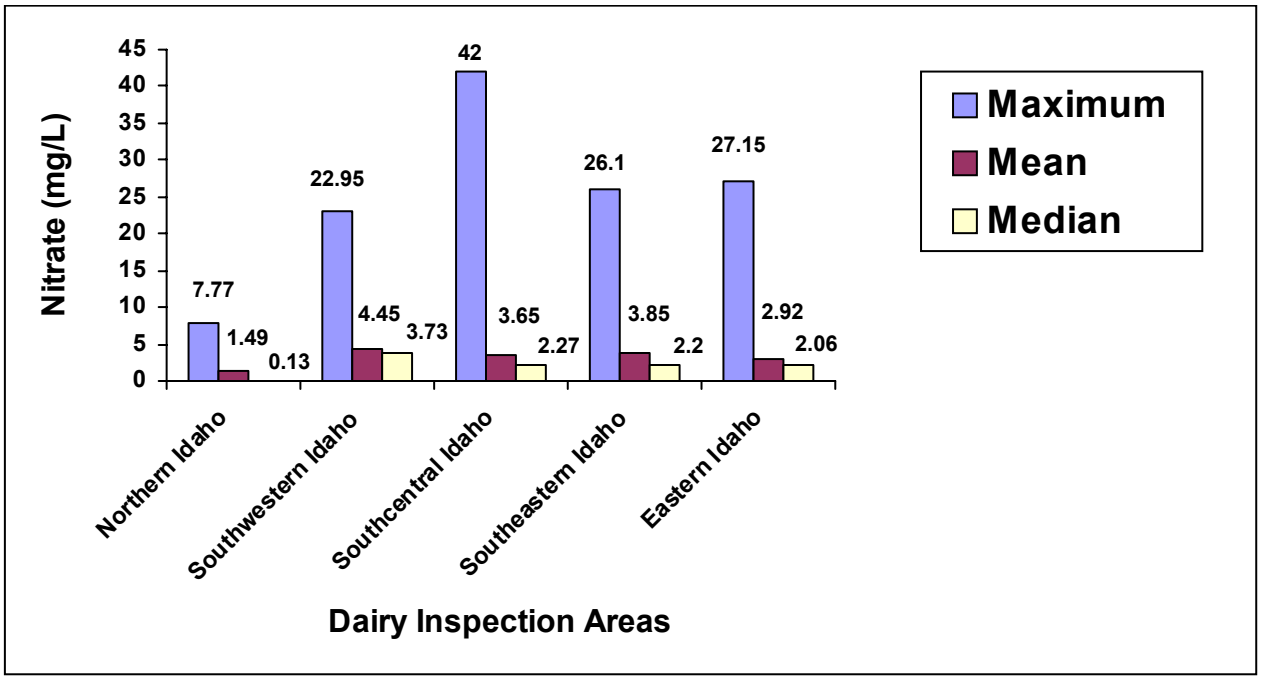

Figure 2. Statistical comparison of ground water nitrate concentrations per dairy inspection area.

Table 4. Statistical comparison of ground water nitrate concentrations by region for dairy well locations and IDWR Statewide Program wells locations.

Inspection Area	Nitrate Data Source	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Number of well locations
Northern Idaho	ISDA Dairy Wells	7.77	1.49	0.13	14
	IDWR Statewide Program	19.0	0.79	0.14	263
Southwestern Idaho	ISDA Dairy Wells	22.95	4.45	3.73	90
	IDWR Statewide Program	110.0	3.36	1.8	437
Southcentral Idaho	ISDA Dairy Wells	42.0	3.65	2.27	434
	IDWR Statewide Program	19.0	2.70	2.3	271
Southeastern Idaho	ISDA Dairy Wells	26.1	3.85	2.2	66
	IDWR Statewide Program	35.0	2.56	1.38	177
Eastern Idaho	ISDA Dairy Wells	27.15	2.92	2.06	157
	IDWR Statewide Program	35.0	2.08	1.38	279

of nitrate samples taken during the four-year period. All wells tested by ISDA that are discussed in this technical summary are located at dairies, selectively biasing the resulting dairy nitrate data set.

Statistically, low nitrate levels for both the IDWR well samples and the ISDA dairy well samples occur in northern Idaho. Northern Idaho dairy well results (14) statistically show the lowest overall nitrate mean (1.49 mg/L), median (0.13) and maximum (7.77 mg/L) values of any of the regions (Table 4). Although the sample population was very different from the two data sources, the results are similar. Southwestern Idaho dairy well results statistically produced the greatest mean (4.45 mg/L) and median (3.73 mg/L) values (Table 4). The sample population was very different from the two data sources. The dairy wells have greater maximum nitrate values with the exception of the IDWR maximum value of 110 mg/L. The greatest dairy nitrate value of 42 mg/L was found in south central Idaho within Blaine County. South central Idaho dairy wells represent a large population (434 wells) for comparative purposes (Table 4). The mean (3.65 mg/L) and the median (2.27 mg/L) values were similar to the Statewide Program results.

Comparison of Dairy Data to ISDA Regional Nitrate Data

The ISDA dairy nitrate data was compared to nitrate data from the ISDA Regional Agricultural Ground Water Monitoring Program. The design and the population of wells tested in the two programs vary. The two data sets were compared because they both tested wells in regions with similar hydrogeologic conditions. The ISDA data selected for this comparison is data collected during the summer of 1999. In each regional aquifer study, the ISDA program is based on randomly selecting wells from well logs which are then sampled annually for a five year period. The total number of wells listed in Tables 5 and 6 represent the locations visited for sampling.

Gem and Payette Counties Nitrate Data

Nitrate statistics at dairy wells in Gem and Payette Counties are somewhat different than the ISDA regional data. There were 45 wells sampled in the ISDA regional program and 25 wells sampled for the dairy program. A greater percentage of dairy wells (36%) were over 5 mg/L versus the ISDA regional wells (14%) (Table 6). The mean (4.78 mg/L) and median (4.33 mg/L) nitrate values for the dairy wells were greater than the correspond-

Table 5. Comparison of nitrate statistics per region for ISDA dairy well monitoring and the ISDA Agricultural Ground Water Regional Monitoring Program.

Inspection Area	Nitrate Data Source	Maximum Nitrate Value (mg/L) / # of wells ≥ 10 mg/L	Mean (mg/L)	Median (mg/L)	Number of wells
Gem and Payette Counties	ISDA Dairy Wells	17.1 / 2	4.78	4.33	25
	ISDA Regional GW Project 770 (1999 data)	16.4 / 3	2.48	1.26	45
Twin Falls County	ISDA Dairy Wells	17.3 / 7	6.15	6.03	92
	ISDA Regional GW Project 780 (1999 data)	14.4 / 1	4.95	5.09	74
Gooding, Jerome, Lincoln Counties	ISDA Dairy Wells	19.2 / 3	2.20	1.59	253
	ISDA Regional GW Project 750 (1999 data)	16 / 2	2.07	1.5	73
Minidoka County	ISDA Dairy Wells	8.08 / 0	3.63	3.06	37
	ISDA Regional GW Project 730 and 740 (1999 data)	28 / 2	4.25	3.6	89
Cassia County	ISDA Dairy Wells	19.9 / 11	6.07	4.81	45
	IDWR Regional GW Project 790	15.7 / 7	6.02	5.64	46

ing data for the ISDA regional sampling (2.48 and 1.26 mg/L) (Table 5). The percentage of wells with nitrate over 10 mg/L was similar for the two programs (Figure 3) (Table 5).

Twin Falls County Nitrate Data

Nitrate statistics at dairy wells in Twin Falls County are somewhat different compared to the ISDA regional data. There were 74 wells sampled in the ISDA regional program and 92 wells sampled for the dairy program. A larger percentage of dairy wells (67%) were over 5 mg/L versus the ISDA regional wells (51%) (Table 6). In addition, a greater percentage of dairy wells (100%) were over 2 mg/L versus the ISDA regional wells (86%) (Table 6). The mean (6.15 mg/L) and median (6.03 mg/L) nitrate values for the dairy wells were slightly greater than the corresponding data for the ISDA regional sampling (4.95 & 5.09 mg/L) (Table 5). The maximum nitrate values were about the same for both studies, however the dairy monitoring had a greater number of detects (7 wells) over 10 mg/L than the regional monitoring program (1 well) (Figure 3).

The Twin Falls County monitoring by both programs indicates that the aquifers have been impacted by nitrate. The data comparisons indicate a greater concern for nitrate contamination at or around dairy locations in certain areas of Twin Falls County. Further evaluations will be necessary for determination of this trend and nitrate source.

Gooding, Jerome, and Lincoln Counties Nitrate Data

Nitrate statistics at dairy wells in Gooding, Jerome, and Lincoln Counties are somewhat similar to the ISDA regional data. However, there were 73 wells sampled in the ISDA regional program versus 253 wells sampled for the dairy program. A similar percentage of dairy wells (7%) were over 5 mg/L versus the ISDA regional wells (6%) (Table 6). Both data sources had the same percentage (38%) of wells over 2 mg/L (Table 6). All wells in both projects had nitrate over the laboratory detection limit. The mean (2.2 mg/L) and median (1.59 mg/L) nitrate values for the dairy wells were nearly the same as the corresponding data for ISDA regional sampling (2.07 & 1.5 mg/L) (Table 5). The frequency and concentrations of maximum nitrate values were about the same for both studies (Table 5) (Figure 3).

Minidoka County Nitrate Data

Nitrate statistics at dairy wells in Minidoka County are somewhat similar to the ISDA regional data. However, there were 89 wells sampled in the ISDA regional program versus 37 wells sampled for the dairy program. A similar percentage of dairy wells (32%) were over 5 mg/L versus the ISDA regional wells (33%) (Table 6). Dairy well data had a smaller percentage (62%) of detections over 2 mg/L than ISDA regional well data (72%) (Table 6). That could be attributed to the larger number of wells sampled (35) by the regional project in the shallow alluvial aquifer near Paul and Rupert. This shallow alluvial aquifer commonly has higher detections of nitrate than the deeper basalt aquifer in the northern part of the county.

The mean (3.63 mg/L) and median (3.06 mg/L) nitrate values for the dairy wells were less than the corresponding data for the ISDA regional sampling (4.25 & 3.6 mg/L) (Table 5). The frequency and concentrations of maximum nitrate values were different for the two studies (Table 5) (Figure 3). The high nitrate value for the dairy wells was 8.08 mg/L (Table 5). The regional study had two detections over 10 mg/L with the maximum value being 28 mg/L (Table 5). Again, this may be attributed to a greater number of ISDA regional wells sampled in the alluvial aquifer.

West Cassia County Nitrate Data

Nitrate statistics at dairy wells in West Cassia County are similar to the ISDA regional data. There were 46 wells sampled in the ISDA regional program versus 45 wells sampled for the dairy program. A similar percentage of dairy wells (48%) were over 5 mg/L versus the ISDA regional wells (52%) (Table 6). The dairy well data had a smaller percentage (66%) of wells over 2 mg/L than the regional data source (85%) (Table 6). The percentage of dairy wells (24%) over 10 mg/L was higher than the regional study (15%) however. This possibly could be attributed to local-

Table 6. Comparison of nitrate statistics per region for ISDA dairy well monitoring and the ISDA Agricultural Regional Monitoring Program.

Inspection Area	Nitrate Data Source	Nondetect (< 0.05 mg/L) (ND) (% of total)	ND – 2 mg/L (% of total)	2 – 5 mg/L (% of total)	5 – 10 mg/L (% of total)	> 10 mg/L (%of total)	Number of wells
Gem and Payette Counties	ISDA Dairy Wells	5 (20%)	5 (20%)	6 (24%)	7 (28%)	2 (8%)	25
	ISDA Regional GW Project 770 (1999 data)	0 (0%)	27 (60%)	12 (27%)	3 (7%)	3 (7%)	45
Twin Falls County	ISDA Dairy Wells	0 (0%)	0 (0%)	31 (34%)	54 (59%)	7 (8%)	92
	ISDA Regional GW Program 780 (1999 data)	3 (4%)	7 (9%)	26 (35%)	37 (50%)	1 (1%)	74
Gooding, Jerome, Lincoln Counties	ISDA Dairy Wells	0 (0%)	158 (62%)	78 (31%)	14 (6%)	3 (1%)	253
	ISDA Regional GW Project 750 (1999 data)	0 (0%)	46 (63%)	23 (32%)	2 (3%)	2 (3%)	73
Minidoka County	ISDA Dairy Wells	1 (3%)	13 (35%)	11 (30%)	12 (32%)	0 (0%)	37
	ISDA Regional GW Project 730 and 740 (1999 data)	4 (4%)	19 (21%)	36 (40%)	28 (31%)	2 (2%)	89
Cassia County	ISDA Dairy Wells	0 (0%)	15 (33%)	8 (18%)	11 (24%)	11 (24%)	45
	ISDA Regional GW Project 790 (1999 data)	1 (2%)	6 (13%)	15 (33%)	17 (37%)	7 (15%)	46

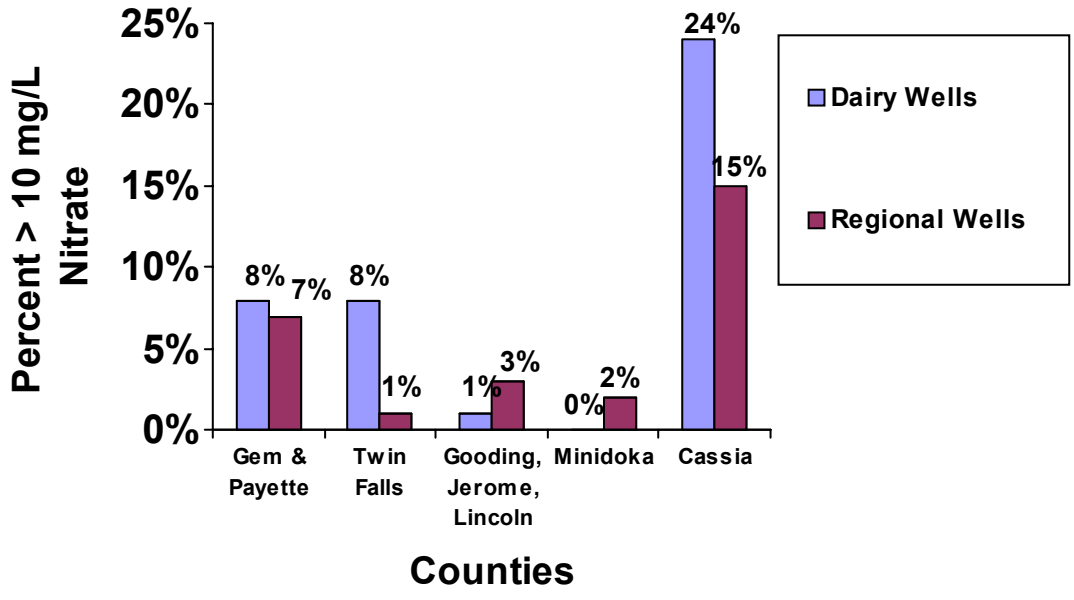

Figure 3. Comparison of wells (%) above 10 mg/L in select counties (based on ISDA monitoring).

ized impacts from the dairies.

The mean (6.07 mg/L) and median (4.81 mg/L) nitrate values for the dairy wells were similar to the corresponding data for the ISDA regional values were slightly different for the two studies (Table 5) (Figure 3). The dairy well results had 11 detections over 10 mg/L with a high of 19.9 mg/L. The regional study results had 7 detections over 10 mg/L with a high of 15.7 mg/L (Table 5). The West Cassia County monitoring indicates an aquifer that is impacted by nitrate.

Isotope Testing

ISDA is testing dairy wells for nitrogen isotopes to assist in determining source of nitrate. As of the end of July 2000, ISDA staff had resampled the majority of dairy wells over 10 mg/L for nitrogen isotope ($^{15}N/^{14}N$ ratios or $\delta^{15}N$) testing. Samples were sent to the University of Illinois, $\delta^{15}N$ Analysis Service, Department of Natural Resources and Environmental Sciences, in Champaign-Urbana for testing of nitrogen $\delta^{15}N$. At 10 percent of the sites, duplicates and split samples were taken. Duplicate samples were also sent to the University of Illinois Laboratory. The split samples were sent to the University of Nebraska Lincoln Isotope Laboratory for testing of nitrogen $\delta^{15}N$. Each university laboratory also runs internal quality assurance quality control checks.

Nitrogen isotopes are a useful indicator for determining sources of nitrate. Nitrogen sources include commercial fertilizer, animal or human waste, precipitation, or organic nitrogen in soil. Each source type has a distinguishable $\delta^{15}N$ range. Typical values of $\delta^{15}N$ for sources of potential nitrate contamination are listed in Table 7.

Table 7. Typical $\delta^{15}N$ values per nitrate source (Source: Seiler, 1996).

Potential Contaminant Source	$\delta^{15}N$-NO_3 (o/oo)
Commercial Fertilizer	-4 to +4
Animal or human waste	Greater than +10
Precipitation	-3
Organic nitrogen in soil	+4 to +9

Note: $\delta^{15}N$ values between four and nine also may suggest multiple nitrogen sources.

Through the end of July 2000, there were 43 dairy wells that were found to be over 10 mg/L. All 43 wells were tested for $\delta^{15}N$. One well was found to be in the commercial fertilizer range, three in the animal or human waste range, and 30 wells were in the organic nitrogen range (Table 8). Results from nine samples were not returned from the laboratory or entered into the database at the time of this publication.

Table 8. Range of test results for dairy well locations tested for $\delta^{15}N$.

$\delta^{15}N$-NO_3 (o/oo)	Number of wells per $\delta^{15}N$-NO_3 (o/oo) Range	Potential Contaminant Source
-4 to +4	1	Commercial Fertilizer
Greater than +10	3	Animal or human waste
-3	0	Precipitation
+4 to +9	30	Organic nitrogen in soil
Data not available at time of publication	9	------

The well within the commercial fertilizer $\delta^{15}N$ range is located in a shallow aquifer in Bingham County (Table 9). This well has an isotope value of 3.72 and a nitrate value of 15.88 mg/L. This dairy site and well location are in an isolated area of west Bingham County that is surrounded by agricultural fields commonly cropped in potato-grain rotations.

The dairy site and well location in Caribou County are situated in an area of shallow soils and fractured basalt with a shallow depth to ground water. The well sample had an isotope value of 15.58 and a nitrate value of 26.1 mg/L (Table 9).

Table 9. Nitrogen isotope ($\delta^{15}N$) testing results for select dairy well locations.

$\delta^{15}N$-NO_3 (o/oo) ranges.	County	$\delta^{15}N$-NO_3 (o/oo)	Nitrate Value
-4 to +4	Bingham	3.72	15.88
Greater than +10	Caribou	15.58	26.1
	Franklin	19.98	13.8
	Gooding	13.49	19.2

The Franklin County site is located in an alluvial flood plain with a shallow well and shallow depth

to ground water. The well sample had an isotope value of 19.98 and a nitrate value of 13.8 mg/L (Table 9).

The Gooding County site is located near Hagerman with shallow soils overlying fractured basalt and a relatively shallow depth to ground water. The well sample had an isotope value of 13.49 and a nitrate value of 19.2 mg/L (Table 9).

Further assessment and work will be done for sites where the data has not been received or processed yet. An evaluation of each site and an assessment of nitrate source will be implemented for all dairy wells with nitrate above 10 mg/L.

ISDA Follow-up To Elevated Nitrate Detections

ISDA dairy inspectors, technical service engineers, and water quality personnel currently are conducting follow-up testing and evaluation of dairy operations and wells showing elevated nitrate. Dairy wells showing nitrate above 10 mg/L will be evaluated first. However, dairy well samples between 5 and 10 mg/L for nitrate also will be evaluated, concentrating on the sites between 8 and 10 mg/L. Dairy well samples returning $\delta^{15}N$ isotope values greater than 10 (o/oo) will be given highest priority.

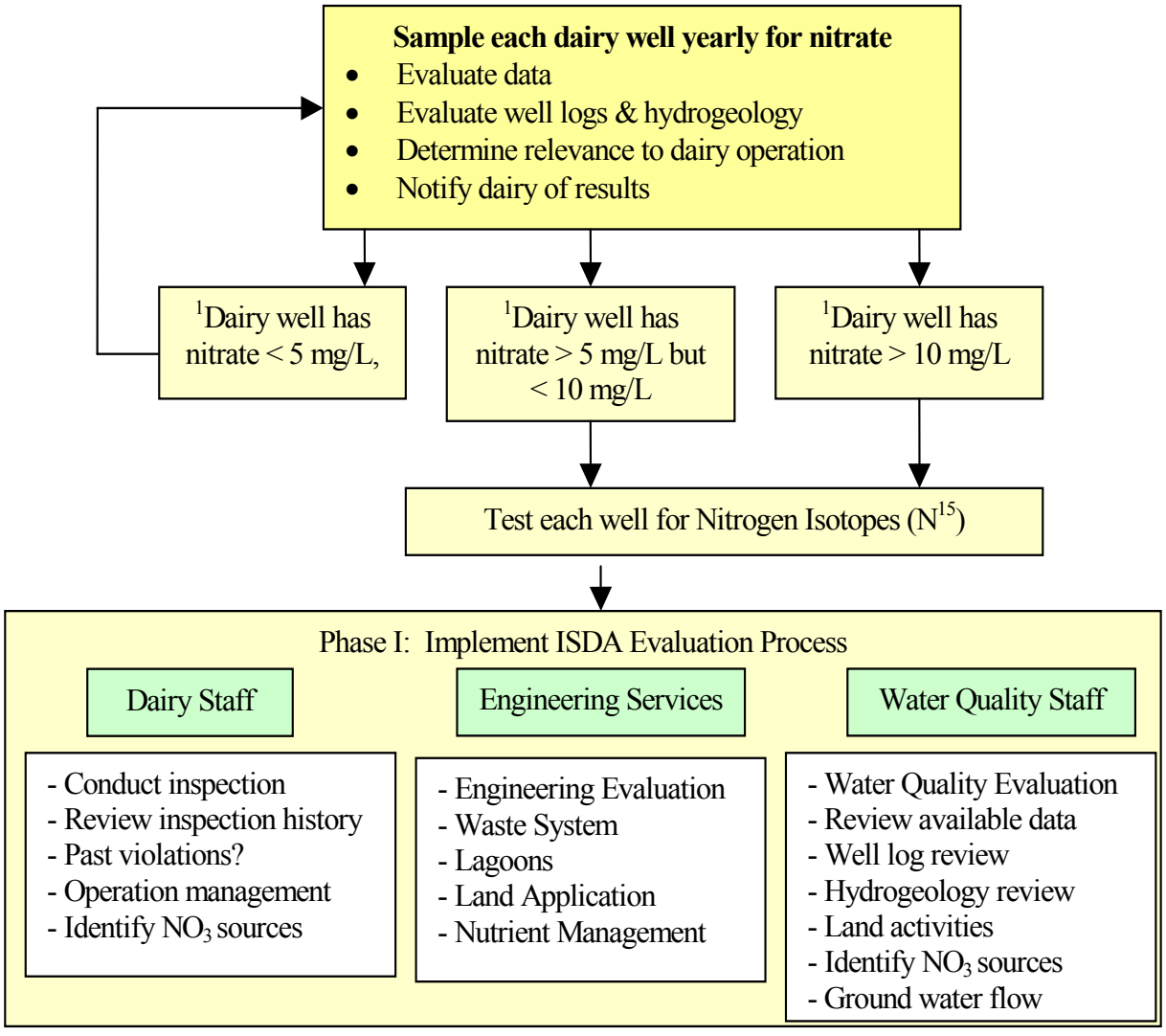

Figure 4. Dairy facility follow-up approach and roles of ISDA personnel for sites that are between 5 and 10 mg/L and above 10 mg/L for nitrate.

ISDA has started conducting multidisciplinary evaluations of the facilities with nitrate greater than 10 mg/L. At these sites, ISDA is also evaluating the surrounding landscapes around the dairies to assist in determining nitrate source. Figure 4 displays the general process to be followed and the roles of various ISDA staff. Small local monitoring projects will be established around each dairy with nitrate detections greater than 10 mg/L and isotope values greater than 10 (o/oo). ISDA is currently conducting this type of work in other areas where there are nonpoint source nitrate or pesticide concerns.

ISDA will evaluate: water quality data; well logs; hydrogeology; relative location of the well to dairy waste systems, corrals, and land application sites; and determine the relevance to each dairy operation. After the nitrate and isotope tests have been evaluated, ISDA staff will conduct a follow-up evaluation of the dairy. Individual localized monitoring projects will be implemented.

Dairy Bureau staff will conduct inspections; review inspection history, past violations, and operation management; and assist in defining nitrate sources (Figure 4). ISDA engineering staff will conduct evaluations of waste systems, lagoons, land application, and nutrient management plans (Figure 4). ISDA water quality staff will conduct water quality evaluations; review available data, well logs, hydrogeology, and land activities; determine ground water flow; and identify nitrate sources (Figure 4).

Preliminary Conclusions and Recommendations

Developing a step-by-step strategy for evaluating dairy operations is important to both the dairy industry, the citizens of Idaho, and the protection of Idaho ground water. Evaluating ground water underlying dairy operations in Idaho will assist in determining if dairy operations are in compliance with laws and rules. Sampling dairy wells and testing for nitrate, nitrogen isotopes, and other constituents will assist in determining sources of nitrate. These efforts may also indicate that nitrate sources could be from irrigated agricultural fertilizer applications, third party animal waste applications, animal operations other than dairies, septic systems, or other sources. Once a nitrate source is identified, ISDA will work with the appropriate groups and agencies to prevent further contamination.

The greatest concerns for nitrate detections are in southern Idaho. Out of 761 wells evaluated so far, 6% are greater than 10 mg/L and 19% are between 5 and 10 mg/L for nitrate. Dairies with detections above 10 mg/L appear to be located at sites with one or more of the following characteristics: relatively shallow ground water, wells completed in a shallow or vulnerable aquifer, shallow soils, course textured soils, and sites that are over fractured basalt with relatively shallow ground water. Certain counties, such as Cassia and Twin Falls Counties have widespread elevated nitrate detections. Some of the higher nitrate detections are at dairies that are clustered near each other south of Burley in Cassia County, and in Twin Falls County near Buhl. There are other potential sources of nitrate in these areas besides dairy operations. Further investigation and evaluation will be necessary to determine nitrate source(s) in these locations.

Comparing dairy to IDWR data indicates some differences either related to maximum or mean nitrate values within aquifers located in southwest and south central Idaho. Dairy and ISDA regional nitrate data are somewhat different in Payette, Gem, Twin Falls, and Cassia Counties where dairy nitrate values tend to have higher statistical values.

Preliminary isotope testing indicates a few dairies have animal istope signatures, one dairy has a fertilizer signature, and numerous dairies have inorganic nitrogen signatures or possibly a mixed source signature. Further testing will be done to determine sources of nitrate for those wells above 5 mg/L with a focus on those greater than 10 mg/L.

Further work to be done includes: further evaluation of first-year data, continued database entry, continued nitrate sampling, evaluation of well logs and hydrogeology, assessment of those

dairies that have elevated ground water nitrate concentrations, and identification of nitrate sources. ISDA will be implementing the followup approach displayed in Figure 4. ISDA water quality staff will be working with ISDA engineers and Dairy Bureau staff to make pollution abatement recommendations.

Where there is evidence that a dairy is a source of nitrate and contributing to aquifer degradation, further compliance and operation changes will be implemented through the Dairy Bureau. Installation and sampling of monitoring wells at these sites is recommended. Where there is evidence that nitrate is coming from other sources, ISDA will work with those land owners, the Idaho Soil Conservation Commission, the Soil and Water Conservation Districts, the USDA Natural Resources Conservation Service, and other cooperating agencies to abate the problem.

Acknowledgements

ISDA Agricultural Resources Division thanks the dedication and efforts of Dairy Bureau Chief Marv Patten and his inspection staff. The Dairy Bureau staff is responsible for conducting the initial round of sampling at the permitted dairy operations. Also, the work of the various laboratories is appreciated including the: University of Illinois $\delta^{15}N$ Analysis Service in Champaign Urbana, Illinois; University of Nebraska Lincoln Isotope Laboratory in Lincoln, Nebraska; Health and Welfare Laboratory in Coeur d' Alene, Idaho; Analytical Laboratory in Boise, Idaho; Magic Valley Laboratory in Twin Falls, Idaho; Health and Welfare Laboratory in Boise, Idaho; and Forsgren Associates, Inc. in Rexburg, Idaho. The authors of this report also thank Ken Neely of IDWR for his valuable review and input.

References

Crockett, J.K., 1995, Idaho Statewide ground water quality monitoring program - summary of results, 1991 through 1993. Idaho Department of Water Resources. Water Information Bulletin No. 50 Part 2. P.

Neely, K.W. and Crockett, J.K., 1998, Ground water quality characterization and initial trend analysis for the Treasure Valley shallow & deep hydrogeologic subareas: Idaho Department of Water Resources, Water Information Bulletin No. 50, Part 3, 90 p.

Neely, K.W. and Crockett, J.K., 1999, Nitrate in Idaho's Ground Water. Idaho Department of Water Resources. Technical Results Summary #1. 12 p.

Seiler, R.L., 1996, Methods for identifying sources of nitrogen contamination of ground water in valleys in Washoe County, Nevada: U.S. Geological Survey Open-File Report 96-461, 20 p.